in none of the photographs was the symmetrical diagonal movement of the successive threes disturbed between the 2nd and 12th pairs of legs inclusive. This apparently simultaneous motion of three adjoining legs may probably be explained by supposing a series of waves, whose crests traverse three legs in the $\frac{1}{70}$th of a second, to be passing along the body, since the different photographs show different legs moving in threes; thus in one photograph the 6th, 7th, and 8th on the left side are seen to be moving forward, while in another the 5th, 6th, and 7th, are moving.

Since reading the paper at the Royal Dublin Society, Mr. G. H. Carpenter brought to my notice two papers by M. Jean Demoor, "Recherches sur la Marche des Insectes et des Arachnides" (*Archives de Biologie*, 1890) and "Recherches sur la Marche des Crustacés" (*Archives de Zoologie Expérimentale et Générale*, 1891). M. Demoor points out the simultaneous use of the tripod in the insects which he examined, but as he did not use photography he does not seem to have observed the minute want of synchronism of the legs of a tripod. Figs. 4 and 5 illustrate this.[1] These are two photographs taken of the same specimen of *Blaps mucronata*. Fig. 4 is from a photograph taken with a long exposure, and shows the 1st and 3rd of the left side, and the 2nd of the right moving at the same time, just as it appears to the eye. Fig. 5 is from a photograph taken with less than half the exposure of 4, and shows that while the 1st leg on the right side is raised off the ground, the 3rd on the same side and the 2nd on the left have not yet been raised. That they have not been raised and are now come to rest is shown by their backward position with regard to the body and other legs. These two photographs also show that the antenna is often twitched almost simultaneously with the motion of the 1st leg of its side. M. Demoor also observed a scorpion (*Buthus australis*), but its method of progression does not seem to have agreed with that of the scorpions (*Buthus europæus*) which I observed. He has not, so far as I know, recorded any observations on spiders.

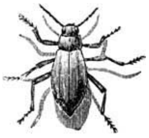

Fig. 4.

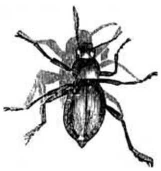

Fig. 5.

Henry H. Dixon.

Trinity College, Dublin, June.

ON IRON ALLOYS.

THE merely mechanical expert in the working of metals would naturally consider it probable that a given metal when fused with another would communicate its physical properties, roughly, in proportion to the quantity added. A soft, tough metal added to iron would, from his point of view, render the latter softer; a brittle or hard metal would have the contrary effect, and so on throughout the whole series of metallic alloys.

Actual experiment would soon, however, show the fallacy of this, and that in the majority of cases no reliance could be placed on this assumption solely based on the physical properties of the elements severally considered. A further study of the laws which govern chemical combination would quickly show that alloys formed by fusion were not merely intermixtures, but that something else took place, bodies being often produced, or rather formed, differing considerably from the metals severally used. It would therefore be fair to assume that the metals entered into combination with each other, and yet it would be found that the problem even at this stage was not completely solved.

Further inquiry and experiment would indicate that it was not always possible to prove that chemical combinations "were in all instances" formed by fusion alone. Instead of this something closely akin to only an intermixture of the metals occurred; second, one of the metals had apparently dissolved in the other; third, it was difficult to differentiate betwixt intermixture and solution. Here we are on all fours with modern ideas which seem to have met with general acceptance, although it is not denied that elements or metals are capable of chemically combining with each other. We are not, however, quite prepared to draw a hard and fast line betwixt chemical combination of the metals with each other, solutions, and intermixtures of metals. One appears to merge into the other, and no good reason "so far as is known" can be given why solution, as ordinarily understood, or as defined by Van 't Hoff and others, may not be as applicable to fused metals as to the solution of certain salts in water.

Water at 60° is nothing more nor less than fused ice; fused iron, therefore, may obey the same laws, and, "like water," may be capable of dissolving certain substances, and rejecting others, temperature constituting the sole difference—or plainly, solid ice is fusible at 60°, iron at about 2500°.

Now what happens in the case of water? Certain bodies are soluble in it, others not; on lowering the temperature, these bodies are to a certain extent rejected, and nearly, but not quite, pure ice is formed; and so far as we know this equally applies to fused iron. As an instance, on cooling, the carbon is rejected, and appears in the graphitic[1] form, merely diffused throughout the solid cold metal. It is impossible here to treat this matter in detail; but enough, we think, has been said to indicate that the analogy is fairly complete throughout.

But there is another matter—apart from the solution of foreign bodies in fused ice or iron—which requires to be discussed. Ice dissolves in warm water, and so does cold iron or steel in superheated fused iron; the hot fluid metal from the Bessemer converter fuses or dissolves large lumps of solid steel placed in it as easily as ice is thawed in warm water. Temperature here, in both instances, determines the quantity which can be added; the higher the heat, the greater the quantity which can thus be dissolved or fused, ere the bath becomes thick, pasty, and incapable of being poured out into another vessel.

In so-called solutions the same rule appears to hold good; but, as all chemists know, there are many exceptions; in some cases heat is evolved, in others absorbed; and some bodies are more soluble in the cold fluid solvent.

It is, however, believed that no instance can be quoted of a body being more soluble in iron at a low degree of heat than at a high one. Confining ourselves to hot fluid iron or steel, it apparently readily dissolves cold metal. Similarly, other bodies, such as copper, &c., are dissolved in the same way when added to it.

The cold metal is fused by absorption of the enormous extra heat of the bath, but this may not be strictly true, for something like solution may also take place. In melting iron in the reverberatory furnace it often happens, when the heat is insufficient, that the iron sets in a pasty semi-fluid mass on the bottom of the furnace; the operator then adds some molten iron, and the whole soon becomes fluid.

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[1] Figs. 4 and 5 show the legs, which are raised from the ground, quite sharp. In the negative they are more or less blurred owing to their motion during the exposure.

[1] The relations existing betwixt carbon and iron are peculiar, and require to be separately discussed.

This process is closely akin to solution. It cannot be explained as simple fusion of iron in iron; the molten iron, in fact, seems to exert a solvent action on the pasty metal, and heat alone plays only a secondary part. This may seem absurd to those not practically engaged in the manufacture of iron, but the fact remains as the result of the experience of iron-workers.

It follows that other metals can be similarly taken up, and the theory of certain iron alloys simplified. There are certain metals intimately related to iron on the periodical scale of the elements, also by atomic volume and atomic weight, and their combination with iron may be achieved by fusion, and possibly something like solution as well, as described, resulting in the production of a similar homogeneous product, which compound metal cannot well be termed either a solidified solution of one metal into another, a chemical combination, or intermixture of metals. The physical properties of this alloy, of course, are different from those of iron. This seems an extreme view to take, but it may be mentioned that the absolutely pure elements prepared by special experts are known in some instances to differ somewhat from those accepted as such in an ordinary laboratory. It has been also noted that the so-called impurity extracted does not differ very greatly from the pure product, and yet is not precisely the same—(quoting from memory, "this applies especially to alumina," why not iron?)

As the result of an extensive experience in the chemical examination of crude iron, steel, and the purest wrought iron, one finds that some metals cling persistently to iron—manganese is always present, nearly all contain copper, nickel also may often be detected if sought for, chromium is not so rare a constituent as might be supposed—all, however, in minute quantities in the case of wrought iron or Bessemer decarbonized metal.

It is curious that these particular metals should cling to iron, but the previous exposition of their relation to iron possibly affords a clue accounting for their persistent presence.

Again, one gathers from a study of Crookes's theory of the genesis of the elements, together with his spectroscopic researches on the composition of the rare earths, yttria, &c., that one so-called element apparently merges into another by almost insensible gradations; it is probable that iron is one of these. Probably it is, for recently it has been all but demonstrated by Prof. Roberts-Austen and others that iron is a compound body, but the relations betwixt these bodies are so close that they have not been isolated, and both are still termed iron.

We have evidence of the possibility of one element merging into another and that iron is not an element, and any one who has studied the periodic law cannot fail to see at least the probability that minute variations in the composition of the elementary bodies may occur, which, however, cannot well be differentiated by our present comparatively coarse analytical methods. Modern methods, however, have been sufficiently accurate to enable us to show that certain relations can be traced throughout the whole series of the elements, and it is in this way that the periodic law has been formulated; and fairly trustworthy atomic weights have been obtained.

Admitting the possibility of minute variations in the composition of elementary bodies, or more correctly that, as urged by Crookes, an element may have more than one atomic weight—the atomic weight accepted being the mean of these: with the periodic law for our guidance, and also attaching due weight to the relations existing betwixt the weights and volume of the atoms, it would seem that the theory advanced of the homogeneous formation of bodies by fusion is in accord with the periodic law, &c., governing the genesis of the elements.

This is equivalent to saying that a fourth state of combination may be imagined, which is—

(1) Neither solution of one metal in another.
(2) Chemical combination of bodies.
(3) Intermixture of bodies.

Hadfield's alloys of iron and manganese may be members of this class.

The first series of these alloys are hard, but when the manganese exceeds 7 per cent. the metal softens; and alloys containing about 12 to 15 per cent. of Mn are strong, tough, cannot be annealed, and cannot be termed either iron or steel.

The same to a certain extent, it is believed, applies to the nickel alloys of iron.

There are other properties, which show that the FeMn alloys are unique.

The alloys of chromium and iron recently made by Mr. Hadfield appear to be of the same class, as also those of nickel and copper with iron.

More plainly, the homogeneous compound bodies previously commented upon may be practically termed elementary bodies similar to the quasi-elements of the rare earths studied by Prof. Crookes. These being, however, within the domain of practical chemistry, it is easy to demonstrate their compound nature, not forgetting "that, as previously noted," it is not easy to entirely eliminate these bodies allied to iron.

We may even go further and assume that the fourth state indicates a species of combination even more intimate than the chemical combination of the chemists.

In fact, reactions "occur quite unlike chemical combination in which atoms only combine with atoms, or bodies are built up atomically." The fourth state may go beyond this; at present this is pure assumption; yet an eminent man of science has suggested that even the atoms may be *smashed*, and this is equivalent to saying that under certain conditions the atom may be non-existent; or in an alloy of, say, iron and nickel or iron and manganese, the separate atoms of iron and manganese do not exist; or in an alloy of iron and Mn or nickel, the severally separate atoms of Fe and Mn, &c., may have no tangible existence apart from each other, as in the case of true chemical combination. Further, this seems more probable if we remember that chemical combinations are, according to modern views, nothing more nor less than structural formations governed by physical laws which regulate their molecular arrangement and the relative positions of the atoms to each other, just as in any structural work built by the hand of man, certain laws or rules must be adhered to. In Nature's laboratory something beyond this may be going on—something, indeed, altogether outside our limited knowledge and experience.

Iron is only one member of a very complicated group, which are closely in accord both as regards their atomic volumes and weights and position on the periodic scale of the elements; and, if we are to accept the work of Prof. Crookes, the well-known investigations of Prof. Roberts-Austen, Osmond, and some data derived from the spectroscopic work of Lockyer, one may be really justified in assuming that quasi-elements may be formed by fusion in the workshop—*i.e.*, elements which can afterwards be dissociated by ordinary chemical processes. The accepted elements, it is true, have not been so dissociated; but it is clear something has been done to indicate the compound nature of at least some of these.

The theory of the possible existence of iron as a quasi element when fused with other elements of like nature clashes with the generally received ideas of chemical combinations or solution; because undoubtedly these are formed.

Granting that chemical combinations likewise take place, does it not seem probable that when these latter are present they may be strictly termed impurities?

If so, iron alloys may be divided into two classes—(1) those in the homogeneous or fourth state, "the true alloys," (2) those in which chemical combinations or solution only takes place; and this latter class may be termed impure metal, in contradistinction to the first or quasi elementary body.

In conclusion it is urged that many of our most eminent metallurgists and men of science have "by very different modes of investigation" come to the conclusion that iron itself is a compound very complex body. It is true that we have only indirect proof of this, but it only remains to find methods of isolating these bodies from each other.

NOTES.

THE medals of the Royal Society are this year awarded as follows:—The Copley Medal to Prof. Rudolph Virchow, For. Mem.R.S., for his investigations in Pathology, Pathological Anatomy, and Prehistoric Archæology; the Rumford Medal to Mr. Nils C. Dunér, for his Spectroscopic Researches on Stars; a Royal Medal to Mr. John Newport Langley, F.R.S., for his work on Secreting Glands, and on the Nervous System; a Royal Medal to Prof. Charles Pritchard, F.R.S., for his work on Photometry and Stellar Parallax; the Davy Medal to Prof. François Marie Raoult, for his researches on the Freezing Points of Solutions, and on the Vapour Pressures of Solutions; the Darwin Medal to Sir Joseph Dalton Hooker, F.R.S., on account of his important contributions to the progress of Systematic Botany, as evidenced by the "Genera Plantarum" and the "Flora Indica," but more especially on account of his intimate association with Mr. Darwin in the studies preliminary to the "Origin of Species." The award of the Royal Medals has been graciously approved by the Queen.

THE American Ornithologists' Union has been holding its tenth congress at Washington. The meetings began on Tuesday, and were held in the U.S. National Museum.

JAMES PLANT, F.G.S., of Leicester, who has just died in his seventy-fifth year, was well known as a local geologist in the midland counties, and as a member for some years of the Committee of the British Association on Erratic Blocks. Such blocks are numerous in Leicestershire, those on the southern side of the county being chiefly derived from the Charnwood range, and Mr. Plant was diligent in searching out and recording the more important of them. Several large boulders striated and partially polished stand in the grounds of the Leicester Museum, rescued by him from various railway cuttings. In 1868 he collected a very fine series of massive specimens representing all the hard rock formations of his native county, for exhibition at the meeting of the Royal Agricultural Society. These were afterwards built up into a great cone about 8 feet in diameter and 15 feet high in the museum grounds, and when the enlargement of the building necessitated its removal they were formed into a diagrammatic geological section on another site. Having to be again removed two years ago some of them were used to form a rough geological model of Charnwood Forest in the Abbey Park. In his latter years Mr. Plant acted as consulting geologist in several important borings for water and coal. The curious concentric rings on the face of a rock in Charnwood Forest interested him greatly, and with much trouble and labour he succeeded in obtaining plaster casts of them. He was active also in procuring photographs of many of the most remarkable geological features of the district.

DR. R. V. WETTSTEIN, of Vienna, editor of the *Oesterreichische Botanische Zeitschrift*, has been appointed ordinary Professor of Botany at the University of Prague.

THE Prussian Government has decided to introduce the use of the Centigrade thermometer instead of that by Reaumur, which is still in use in some parts, and no further Reaumur thermometers are to be supplied to any public officials. The Centigrade thermometer has long been in use in Germany for scientific purposes.

A VALUABLE collection of fossils, minerals, and shells, comprising several thousand specimens, and particularly rich in specimens from the carboniferous formation, has just been presented to the University College of North Wales by Mr. Evan Roberts, of Manchester. It is hoped that this gift will become the nucleus of an important geological collection suited to the educational requirements of a University College, and that similar gifts will from time to time be made to the College by those interested in the progress of geological study.

THE Oxford Medical Society held its first meeting on Saturday last, at the University Museum. Sir Henry Acland presided. The inaugural address was delivered by Sir James Paget. He said they all knew that the practice and science of medicine, or, as it was sometimes called, the science and art of medicine, were by some regarded as things quite distinct, wide apart, and in study almost incompatible. A few there were who had the capacity of pursuing both. The great mass of those engaged in the pursuit of medicine were either practitioners or men devoting themselves to science. Each method of work was essential to the practice of the other. It might be asked how could practitioners work as men of science even where they had the time for it? He believed that would come about by the increase in the teaching of science in all medical schools and Universities. He pointed out the work which might be undertaken by the society, and spoke at length on various subjects which might be studied with advantage. Prof. Burdon-Sanderson said the society had been established for the furtherance and promotion of science, and they wished to make an advance, so to speak, towards the University. There was a yearning in the minds of the medical profession in Oxford to unite itself more closely than it had hitherto with the scientific studies of the University which depended immediately on medicine.

THE weather has continued very unsettled during the past week, the most notable features being the prevalence of fog and abnormally high temperature. During the latter part of last week fog extended over nearly the whole of England, as well as a large part of the Continent. In London and the suburbs intense darkness occurred on several days, interspersed with very short intervals of sunshine, but in the north-western parts of the kingdom the weather was generally fair. These conditions were due to the distribution of pressure, which was cyclonic over the western portion of these islands, but anti-cyclonic over western Europe. Temperature was uniformly high for the season, the daily maxima ranging from about 50° to 60°, and reached 62° in several places in the southern counties on Monday. This maximum is the highest that has been recorded in the neighbourhood of London during the last ten years. In the early part of the present week a deep depression passed to the westward of Ireland from the Atlantic, causing southerly gales in the north and west, with rain in all parts of the country, the amount measured at Valencia Observatory on Monday exceeding an inch. On Tuesday afternoon a fresh depression reached our south-west coasts from the south-eastwards, while a trough of low pressure lay over the Bay of Biscay and France, causing further heavy rains and local fogs. For the week ending the 12th instant the reports show that bright sunshine was, as might have been expected, very deficient generally, especially over northern and eastern England, where the percentage of possible duration was only 9; the lowest